

Radiological evaluation of a high ankle sprain

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A 42-year-old woman with lateral left ankle pain presented to the orthopaedic clinic. She complained of unrelenting left ankle pain following a fall a week earlier. The plain radiographs of her left ankle revealed no evidence of fracture. Following her visit to the clinic, the orthopaedic surgeon ordered a magnetic resonance imaging (MRI) study of the left ankle. The T1- and T2-weighted images demonstrated an abnormal appearance of the anterior inferior tibiofibular (AITF) ligament as well as the anterior talofibular ligament (*Figures 1–3*). Marked subcutaneous edema was evident over the lateral and anterior left ankle. A small ankle effusion was also visualized.

What is the diagnosis and the most common mechanism of injury?

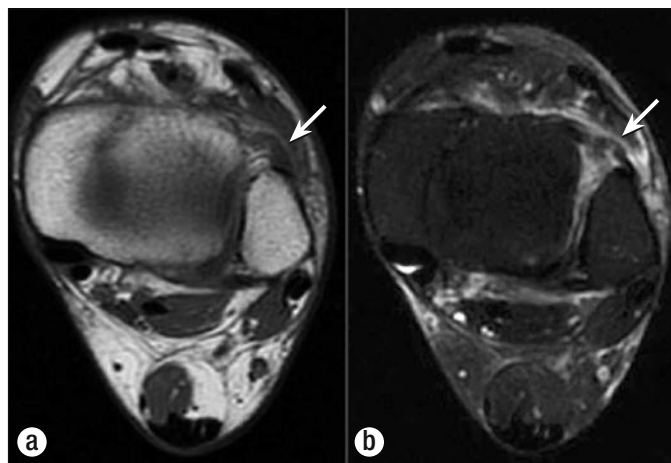


Figure 1. Axial MR images of the left ankle. (a) T1-weighted spin-echo image demonstrates thickening and contour irregularity of the anterior inferior tibiofibular ligament (arrow). (b) Fat-suppressed T2-weighted fast spin-echo image shows intraligamentous edema, contour irregularity, and surrounding edema involving the anterior inferior tibiofibular ligament (arrow).

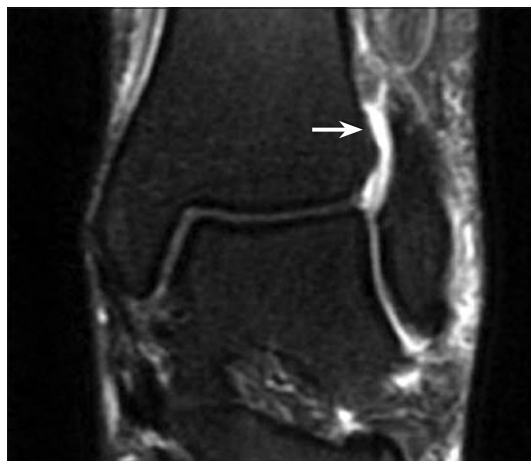


Figure 2. Coronal fat-suppressed T2-weighted fast spin-echo image reveals fluid abnormally extending 2 cm superiorly into the tibiofibular recess (arrow).

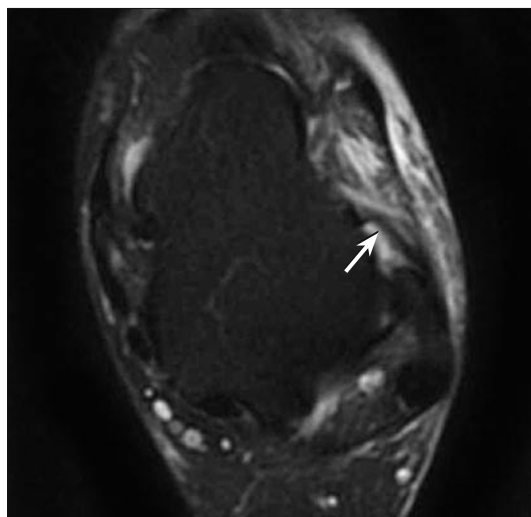


Figure 3. Axial fat-suppressed T2-weighted fast spin-echo image demonstrates edema within and surrounding the anterior talofibular ligament (arrow).

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DIAGNOSIS: Acute distal tibiofibular syndesmot-ic injury of the left ankle, frequently referred to as a *high ankle sprain*. A commonly seen accompanying sprain of the anterior talofibular ligament is also present. The most common mechanisms of injury are external rotation of the ankle and hyperdorsiflexion (1).

DISCUSSION

Ankle sprain is the most frequent sports injury encountered today. The complications include prolonged ankle pain, a high rate of recurrence, and chronic ankle instability (2). Lateral ankle sprains and specifically sprains involving the anterior talofibular ligament are the most common (*Figure 4*). As a result, most of the research related to ankle injuries has focused on the lateral ankle ligaments and inversion ankle sprains. Tibiofibular syndesmot-ic sprains, or high ankle sprains, are less common. However, given the increased severity and long-term sequelae of syndesmot-ic injuries, clinicians must be cognizant of the evaluation, treatment, and rehabilitation of this type of ankle injury.

The articulation of the fibula with the tibia can be categorized into three regions: the superior tibiofibular joint, the interosseous membrane, and the inferior tibiofibular joint. The interosseous membrane holds the fibula and tibia together and stabilizes any posterolateral bowing of the fibula that may occur with weight bearing. The inferior tibiofibular joint consists of the three main syndesmot-ic ligaments: the anterior tibiofibular ligament, the posterior tibiofibular ligament, and the interos-eous ligament (1).

The AITF ligament is sturdy and flat, extending from the longitudinal tubercle on the anterior aspect of the lateral mal-leolus to the anterolateral tubercle of the tibia (*Figure 5a*). The posterior inferior tibiofibular (PITF) ligament has superficial and deep fibers (*Figure 5b*). The superficial fibers extend from the posterior tubercle of the tibia to the posterior lateral mal-leolus. This superficial ligament functions with the AITF liga-ment to secure the fibula close in the fibular groove of the tibia. The deep constituent of the posterior ligament is the transverse tibiofibular ligament. It courses from the posterior tibial margin to the osteochondral junction on the posteromedial distal fibula.

Figure 4. The lateral ligament complex of the ankle consists of three separate ligaments: the anterior talofibular (atf) ligament, the poste-rior talofibular (ptf) ligament, and the calcaneofibular (cf) ligament. The anterior talofibular ligament is the most commonly injured ankle liga-ment. The anterior inferior tibiofib-ular (aitf) ligament is also shown. The posterior inferior tibiofibular is not illustrated. Reprinted from Nielson et al (3) with permission.

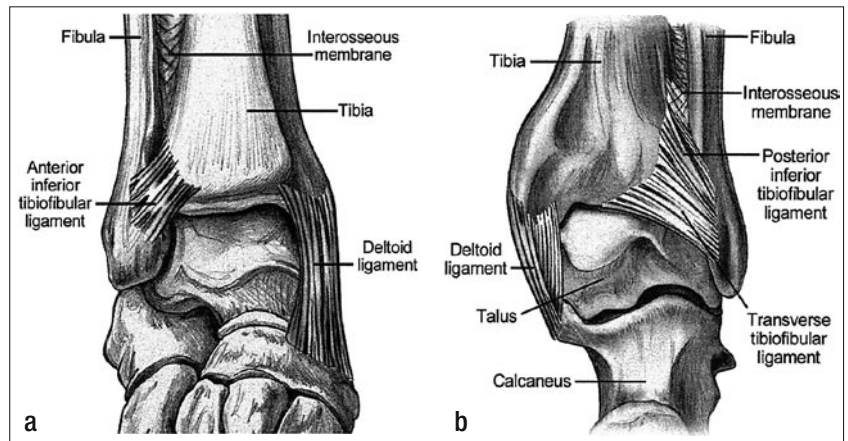
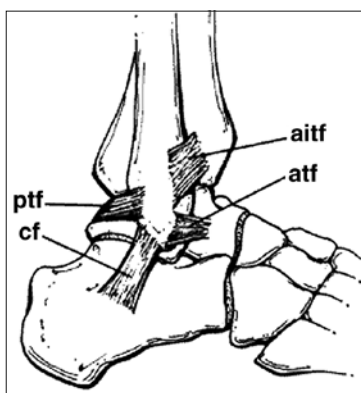


Figure 5. The inferior tibiofibular syndesmot-ic ligaments. (a) Anterior view. The deltoid ligament is a medial ankle ligament complex and is not a part of the tibiofibular syndesmosis. (b) Posterior view. The transverse tibiofibular ligament is the deep component of the posterior inferior tibiofibular liga-ment. Reprinted from Norkus and Floyd (1) with permission.

Finally, the remaining ligament of the syndesmosis is the interos-eous ligament. The interosseous ligament is simply a thickening of the distal interosseous membrane. This ligament is believed to function as a “spring,” permitting slight separation between the medial and lateral malleoli during ankle dorsiflexion (1).

The two most common mechanisms of syndesmot-ic injury are external rotation and hyperdorsiflexion. External rotation damages the tibiofibular syndesmosis by widening the mortise. With a powerful force to the forefoot, the talus rotates later-ally and pushes the fibula externally away from the tibia. This compilation of forces can also tear the interosseous membrane and fracture the proximal fibula, also known as a Maisonneuve fracture. Football is one sport in which external rotation is be-lieved to cause syndesmot-ic injury. For example, external rota-tion of the foot occurs with a blow to the lateral leg of a player who is lying prone, usually in a pile-up. External rotation would also occur in a player receiving a blow to the lateral leg with the foot planted, causing rotation of the body in the opposite direction of the foot. The second mechanism of syndesmot-ic injury is hyperdorsiflexion. With severe dorsiflexion, the talus pushes the malleoli apart. This excessive force can sprain or even rupture the anterior and posterior tibiofibular ligaments. This mechanism occurs when the foot is planted and the athlete falls or is pushed forward (1).

Radiologic evaluation of the injured ankle often begins with standard anteroposterior radiography. Plain radiographs are obtained to look for fractures as well as malalignment of the ankle. Three radiographic measurements may be made on an anteroposterior and mortise radiograph of the ankle to help in assessing for syndesmot-ic injury (*Figure 6*). On the anteropos-terior view, tibiofibular clear space is the horizontal distance measured from the lateral border of the posterior tibial malleolus to the medial border of the fibula. A tibiofibular clear space of >5 mm is considered abnormal. On the anteroposterior view, the tibiofibular overlap is the horizontal distance between the medial border of the fibula and the lateral border of the anterior tibial prominence. A tibiofibular overlap of <10 mm is consid-ered abnormal. Finally, on a mortise radiograph, the medial

Figure 6. Diagram of the ankle shows the tibiofibular clear space (TFCS), tibiofibular overlap (TFO), and medial clear space (MCS). The TFCS and TFO are best assessed on an anteroposterior radiograph, and the MCS is best evaluated on a mortise radiograph. Reprinted with permission from the Lipscomb Clinic Sports Medicine Center.

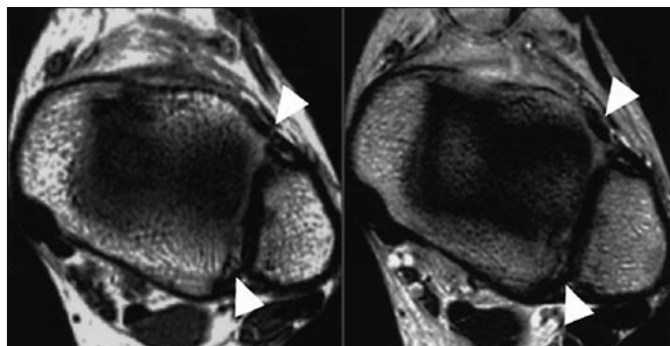
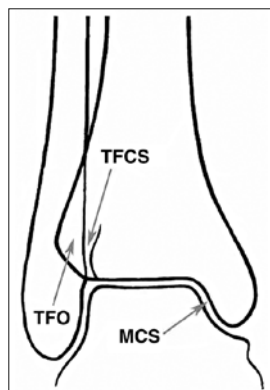


Figure 7. Axial T1-weighted spin-echo and T2-weighted spin-echo MR images of the left ankle demonstrate a normal anterior inferior tibiofibular ligament (top arrowheads) and a normal posterior inferior tibiofibular ligament (bottom arrowheads). These ligaments have a normal bandlike appearance. Reprinted from Oae et al (5) with permission.

clear space is the distance measured between the lateral aspect of the medial malleolus and the medial border of the talus at the level of the talar dome. A medial clear space of >4 mm is considered abnormal (3).

When one or more of these radiographic measurements is abnormal, a syndesmotic injury may be present. However, a tibiofibular syndesmotic injury is difficult to diagnose by plain radiography when tears are incomplete or when there is no diastasis of the distal tibiofibular joint. In other words, a normal tibiofibular radiographic relationship does not preclude a syndesmotic injury. Because of these factors, an MRI study of the ankle should be performed to fully evaluate and diagnose ligamentous injuries (4).

MRI is a remarkably valuable tool for assessing musculoskeletal injuries. The tibiofibular ligaments are well visualized, and as a result, a diagnosis of tibiofibular syndesmotic injury can be made with confidence. The high sensitivity and specificity of MRI for diagnosing syndesmotic injuries has been confirmed with multiple series correlating MRI findings with subsequent arthroscopic findings (5). MRI is most often performed using a 1.5 Tesla superconducting unit with an extremity coil around the ankle. The foot should be positioned at 90 degrees in relation to the leg. To completely evaluate the ankle, the imaging protocol usually consists of coronal and axial T2-weighted fast spin-echo images with fat suppression, axial proton density-weighted fast spin-echo images, sagittal fast spin-echo inversion recovery images, and sagittal and axial T1-weighted spin-echo

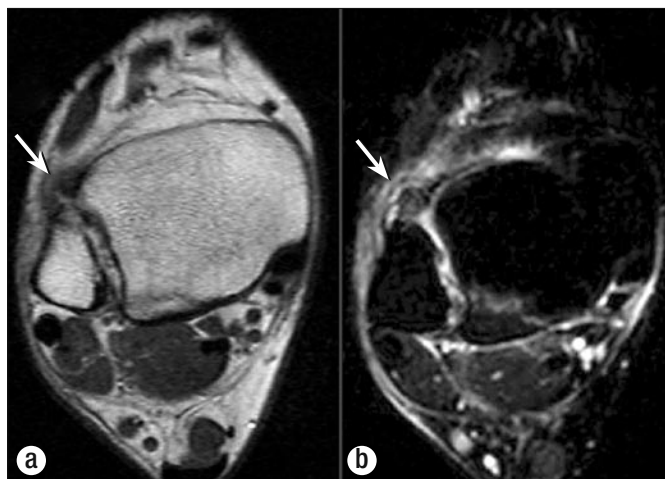


Figure 8. Acute injury of the anterior inferior tibiofibular (AITF) ligament in an 18-year-old woman with right ankle pain. **(a)** Axial T1-weighted spin-echo image of the right ankle shows AITF ligament thickening, contour irregularity, and ligament discontinuity (arrow). **(b)** Axial fat-suppressed T2-weighted fast spin-echo image of the right ankle reveals edema in and around the AITF ligament (arrow).

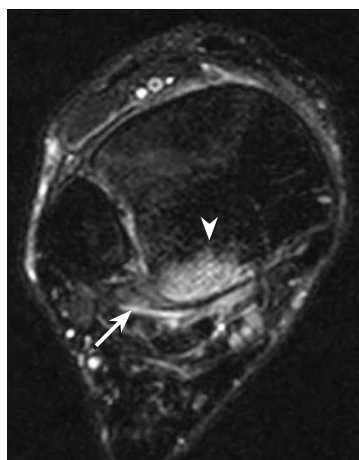


Figure 9. Acute injury of the posterior inferior tibiofibular ligament and bone marrow edema in the posterolateral distal tibia in a 17-year-old hockey goalie. Axial fat-suppressed T2-weighted fast spin-echo image of the right ankle shows posterior inferior tibiofibular ligament thickening and edema (arrow). Additionally, bone marrow edema is visualized in the adjacent posterolateral distal tibia (arrowhead).

images (6). On T1-weighted images, when an injury occurs, there is intermediate signal intensity and blurring of the syndesmotic ligaments. On T2-weighted images, which are sensitive to edema, one may observe ligament thickening, intraligamentous hyperintensity, contour irregularity, frank discontinuity, and interosseous membrane linear hyperintensity (7).

The AITF and PITF ligaments normally have a bandlike appearance. As discussed earlier, the PITF ligament has two components: a superficial ligament and a deep ligament, which is often referred to as the transverse tibiofibular ligament. The normal AITF and PITF ligaments are well seen on axial T1-weighted spin-echo images (Figure 7).

The AITF ligament is the most commonly injured and the most consistently visualized syndesmotic ligament on MRI examinations of the ankle (Figure 8). Ligament thickening, contour irregularity, ligament discontinuity, and surrounding edema are well visualized in this patient.

In another patient, a sprain of the PITF ligament is well illustrated (Figure 9). Ligament thickening, intraligamentous edema, and edema around the ligament are demonstrated. A bone bruise of the adjacent posterolateral distal tibia is also

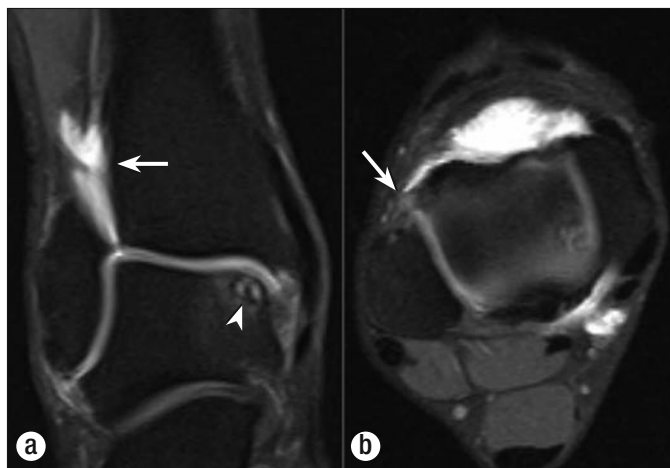


Figure 10. Anterior inferior tibiofibular ligament injury, increased tibiofibular recess height, and osteochondral lesion of the medial talar dome in a 40-year-old man with a right ankle injury. **(a)** Coronal fat-suppressed T1-weighted image of the right ankle with intra-articular gadolinium shows the gadolinium contrast extending more than 2 cm superiorly into the tibiofibular joint recess (arrow). A tibiofibular recess height of >1 cm is diagnostic of a syndesmotic injury. A medial talar dome osteochondral lesion is also present (arrowhead). **(b)** Axial fat-suppressed proton density-weighted image fast spin-echo image of the right ankle with intra-articular gadolinium demonstrates anterior inferior tibiofibular ligament thickening and increased signal (arrow).

visualized. In a fourth patient, an osteochondral lesion of the medial talar dome is seen in conjunction with an injury of the anterior tibiofibular ligament (*Figure 10*). In addition, an intra-articular gadolinium coronal T1-weighted image shows the gadolinium contrast extending superiorly into the tibiofibular joint recess. The tibiofibular recess is defined proximally by the interosseous ligament. In this case, the contrast extends more than 2 cm superiorly into the tibiofibular joint above the level of the lateral talar dome. If the tibiofibular recess fills with fluid or gadolinium greater than a height of 1 cm, this is diagnostic of either an acute or chronic syndesmotic injury. These two cases are good examples of a number of secondary findings commonly seen on MRI in association with injury to the distal tibiofibular syndesmosis. These findings include anterior talofibular ligament injury (seen best in the introductory case), bone bruise, osteochondral lesion, and increased height of the tibiofibular recess (6).

MRI of the ankle is also valuable for evaluating other causes of ankle pain, which may simulate a tibiofibular syndesmotic injury clinically. The differential diagnosis includes anterior talofibular ligament tear, calcaneofibular ligament tear, distal fibular fracture, compartment syndrome, and posterior impingement. Compartment syndrome presents clinically as pain out of pro-

portion to the injury. Posterior impingement is defined as a synovitis of the posterior ankle ligaments (7).

Prompt diagnosis and treatment of distal tibiofibular syndesmotic injuries are important to prevent chronic ankle instability. Mild syndesmotic ligament tears may be treated by requiring the patient to limit or avoid weight bearing for 6 weeks, with close follow-up by an orthopaedic surgeon. In more severe cases, especially in competitive athletes, the treatment consists of surgical screw placement across the syndesmosis. Following surgery, the patient is told to avoid weight bearing for 6 weeks. After 6 weeks, the screw may be removed, and the patient may slowly resume bearing weight on the ankle (8).

CONCLUSION

Ankle injuries and sprains are a frequently encountered problem in clinical practice. Due to the complications of prolonged ankle pain, high recurrence rate, and chronic ankle instability, the proper clinical evaluation, radiological assessment, and treatment of ankle injuries is essential. In particular, distal tibiofibular syndesmotic injuries are often difficult to detect clinically, have a longer recovery time, and may disrupt normal ankle biomechanics if not diagnosed and treated appropriately. While plain radiographs may be helpful if the space between the tibia and fibula is perceptibly widened, in many cases, the tibiofibular relationship is normal despite tibiofibular syndesmotic injuries. For these reasons, an MRI study of the ankle should be performed due to its high accuracy in the diagnosis of tibiofibular syndesmotic disruption, or high ankle sprain.

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